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PERFORMANCE AND ANALYSIS THE EFFECT OF MOBILITY OF COORDINATOR AND END DEVICES IN ZIGBEE USING OPNET

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ABSTRACT

ZigBeewas developed by IEEE 802.15.4 Task Group and ZigBee Alliance. ZigBee (IEEE 802.15.4-2006 standard) is a category in the IEEE 802 family and ZigBee alliance is responsible for ZigBee standard which uses the transported services of the 802.15.4 network specification therefore ZigBee is a specification for a suite of high level communication protocols using small, low-power digital radios based on an IEEE 802 standard for personal area networks. In this research the performance of Mesh is analysedwith the mobility of both ZigBee End Devices and ZigBee coordinator for different trajectories. The performance is analysed in terms of Throughput and Load.

KEYWORDS: WSN, Zigbee, 802.15, OPNET

INTRODUCTION

Wireless sensor networks are an interesting research topic, both in military [1, 2, 3] and civilian scenarios [1, 4].

In particular, remote/environmental monitoring, surveillance of reserved areas etc, are important fields of application of wireless sensor networking techniques. Typically, very low power consumption and low-cost hardware is required [5, 2, 13].

ZigBee is a worldwide open standard for wireless radio networks in the monitoring and control fields.

The standard was developed by the ZigBee Alliance to meet the following principal needs [6, 14]:

- Low cost
- Ultra-low power consumption
- Low data rate (less than 250 Kbps)
- Use of unlicensed radio bands
- Cheap and easy installation
- Flexible and easy installation
- Integrated intelligence for network set-up and message routing

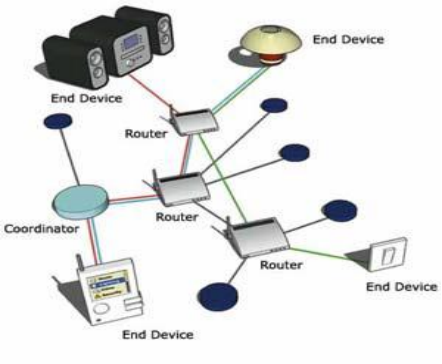

Figure 1: A Typical Example of Zigbee in Home Automation [6]

Architecture

ZigBee has three layers [4, 13]. The top layer is called the application layer (APL). This layer gives the device its functionality. Basically, this layer converts the input into digital data, and/or converts digital data into output. A single device may run multiple applications to perform different tasks (i.e. reading temperature and humidity). The application layer is on top of another layer called the network layer (NWL). The network layer provides ZigBee functionality and acts as a buffer between application layer and data link layer (DLL). The network layer is responsible for network structure, routing, and security such as encryption, key management, and authentication. The data link layer is provided by IEEE 802.15.4 standard. This layer consists of two sub-layersmedium access control layer (MAC) and the physical layer (PHY) [7, 15].

Table 1: Zigbee Protocol Layers

Application layer (APL)
Network layer (NWL)
Medium access control layer (MAC)
Physical layer (PHY)

Device Types

There are three different types of ZigBee devices [9, 10]:

Zigbee Coordinator (ZC)

The most capable device, the coordinator forms the root of the network tree and might bridge to other networks. There is exactly one ZigBee coordinator in each network since it is the device that started the network originally. It is able to store information about the network, including acting as the Trust Centre & repository for security keys.

Zigbee Router (ZR)

Participates in multi-hop routing of messages in mesh and Cluster-Tree networks. As well as running an application function a router can act as an intermediate router, passing data from other devices.

Zigbee End Device (ZED)

It is just a sensor/actuator node. Contains just enough functionality to talk to the parent node (either the coordinator or a router), it cannot relay data from other devices. This relationship allows the node to be asleep a significant amount of the time thereby giving long battery life. A ZED requires the least amount of memory, and therefore can be less expensive to manufacture than a ZR or ZC [7].

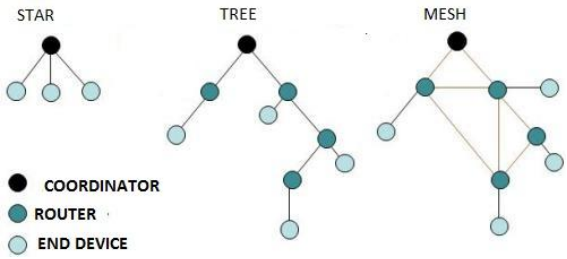

Figure 2: Topologies

The ZigBee standard allows the formation of three types of network topology: star, tree, and mesh[7, 13].

- The star topology is the simplest of the three topologies, consisting of only a single coordinator with a number of end-devices as its children.
- In the case of a tree topology, the devices organize themselves into a tree-like structure with the coordinator representing the root of the tree, routers representing the roots of sub-trees, and end-devices representing leaves.
- In a network of mesh topologyrouters and coordinators form multiple links among each other while having end-devices as their children. Although more complex in its formation and operation, mesh topology is characterized by link/path redundancy which is known to result in improved network robustness and network routing function.

RELATED WORK

In 2010 [8] Harsh Dhaka et al, performed extensive evaluation, using OPNET Modeller, to study the impact of coordinator mobility on ZigBee mesh network. The results show that the ZigBee mesh routing algorithm exhibits significant performance difference when the router are placed at different locations and the trajectories of coordinator are varied. We also show that the status of ACK in the packet also plays a critical role in deciding network performances.

In 2012 [9] Ms. Sonal J. Raneet *al*, proposed an accurate simulation model, the behavior of a mobile Zigbee node passing through the radius of multiple PANs is examined using OPNET simulator. The performance metrics like: PAN Affiliation, Data Dropped, Traffic Received are reported.

In 2012 [10] SR.Ramyahetal, performed extensive network evaluation to study the Effect of coordinator mobility on ZigBee mesh network, using OPNET Modeller. In mobile coordinator, the type of the trajectory along with the node density and the traffic are the major factors that decide the system performance. The results obtained from the wide analysis of ZigBee mesh network shows variation when the routers are placed at Hexagonal configuration with a mobile coordinator. In this paper variation in load metric is analysed in hexagonal configuration by enabling and disabling ACK. Thus the status of ACK also plays a critical role in analysing load metrics.

In 2012[11]NeetiBishtet al author analysed the effect of mobility on the performance of WSN models. We used well known network simulator QualNet5.0 from scalable networks to evaluate the performance of the scenario. Several sensor nodes were randomly deployed in the networks to create sensing phenomena. The performance analysis is based on different network metrics such as total packets received, average end-to-end delay and throughput.

EXPERIMENTAL SETUP

In this research the performance of Mesh is analysed with the mobility of both ZigBee End Devices and ZigBee coordinator. To analyse the effect different scenarios are made. The number of nodes taken are100,150,200.

In each scenario the placement of nodes are random over an area of 100m*100m.The fixed mobility model is used. We used three trajectoriesCircle, inner square and outer square. To get the performance of Mesh, OPNET modeller [12] is used, as OPNET modeller provides a comprehensive development environment supporting the modelling of communication network and distributed systems. OPNET modeller provides better environment for simulation, data collection and data analysis.

RESULTS

Here performance ofMesh is analyzed with the mobility of both ZigBee End Devices and ZigBee coordinator for different trajectories. The result is analysed in terms of Load and Throughput.

Load

It represents the total load (in bits/sec) submitted to 802.15.4 MAC byall higher layers in all WPAN nodes of the network.

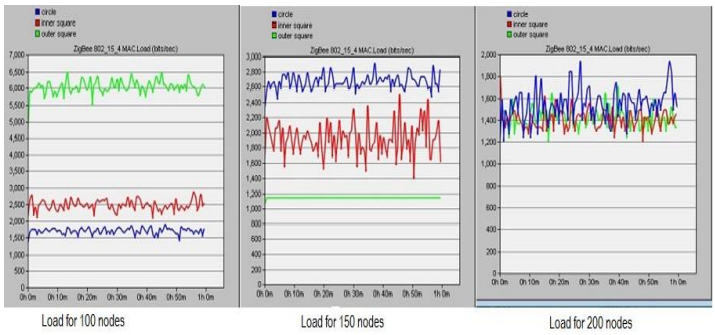

Figure 3: Load without ACK

Figure 3 shows the result of Mesh for nodes 100, 150 and 200 without acknowledgement. The result shows that as we increase the number of nodes from 100 to 150 the load is increase in case of circle trajectory and in case of inner square and outer square it decreases. The load shows most deviation (decrease) in case of outer square as nodes increases. Further we increase the nodes load again decrease for all trajectories. The result also shows that the performance of circle is better as we increase the number of nodes.

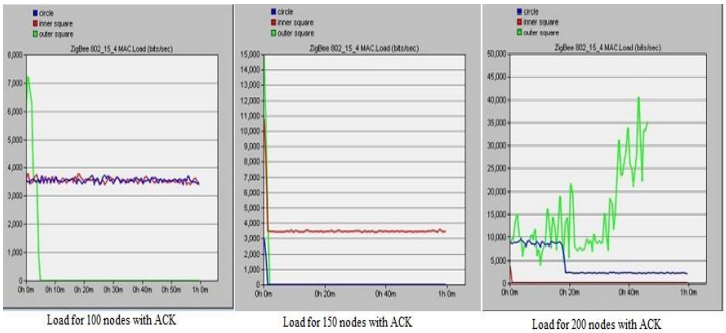

Figure 4: Load With ACK

Figure 4 shows the result of mesh for three trajectories for nodes 100,150 and 200 by using acknowledgement. The figure shows that as we increase the number of nodes the load is increased. The result also shows thatas time passes the load reduces for all trajectories. But only in case of outer square for 200 nodes the load increase with increase of time. The resultalso shows that the performance of outer square is better than other trajectories.

Throughput

It represents the total number of bits (in bits/sec) forwarded from 802.15.4 MAC to higher layers in all WPAN nodes of the network.

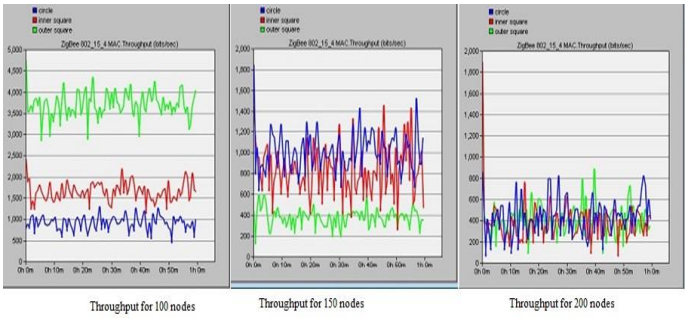

Figure 5: Throughput without ACK

Figure 5 shows the result of throughput for different nodes for three trajectories. The result shows that as we increase the number of nodes throughput decreases for all trajectories. The result also shows that the performance of circle is better as we increase the number of nodes.

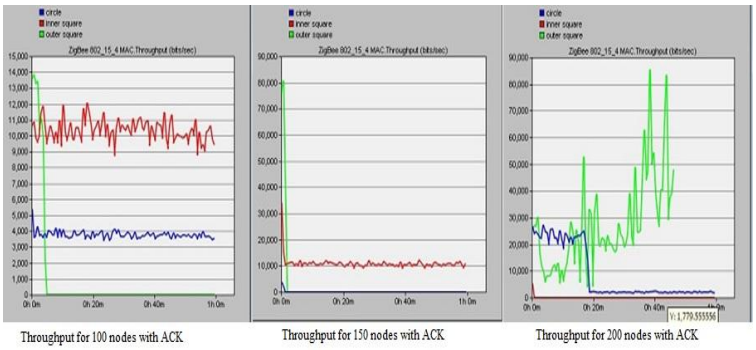

Figure 6: Throughput with ACK

Figure 6 shows the result of three trajectories for node 100,150 and 200 by using acknowledgement. The result shows that as we increase the number of nodes the throughput increases. The result also shows that as time passes the load reduces for all trajectories. The result alsoshows that the performance of outer circle is better than other trajectories.

CONCLUSIONS AND FUTURE SCOPE

In this research the performance of performance of Mesh is analyzed with the mobility of both ZigBee End Devices and ZigBee coordinator. The performance is compared in terms of Load and Throughput. In this research the placement of nodes is random over 100m*100m area. The speed of end devices and coordinator is fixed which is 15m/s. The mobility model used is fixed. We use three trajectories circle, inner square and outer square. The results shows that without using Acknowledgement the performance of circle trajectory is better than other two trajectories but if we use acknowledgement than performance of outer square is better than other two in terms of Load and Throughput. In future one can compare the performance of Star,mesh and tree by increasing the number of nodes, area and by varying different speed.

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AUTHOR'S DETAILS

Dr. Sandeep Singh Kang Working at CGCCOE Landran as HOD (CSE) Since Nov,2007. 2013. He did his B.Tech from Punjab Technical University and M.Tech from Punjabi University Patiala. Recently he has completed his PH.D in Computer Science & Engineering in the area of Wireless Networks. He has total of 10 years of Experience. He has Published 52 Research Papers in International/National Journals and Conferences and attended 12 workshops and FDP's for enhancement of his skills. He has published a BOOK Title: "**Integrated Approach to Network Security".** Besides this, he has guided around 20 Students for PG Research Work and guiding 02 students for doctorate. His area of specialization is Security of Wireless Networks. He is the Life Member of Computer Society of India and Member Board of studies (Computer Science), Punjab Technical University, Jalandhar.